**CATAPULT DESIGN**

**Objective**: To apply the laws of Physics and the equations for projectile motion to design a catapult that can accurately launch a projectile and hit a designated target. Our goal is to calculate and compare experimental data to theoretical data and understand differences between the two.

**Materials and Methods:**

In this lab you will be building small catapults. Your catapult will need to be able to launch a small light weight (2 to5 grams) projectile in the range of 3-6 m. All catapults should be composed of materials “purchased” from the company store. Each team has a store credit of $ 2 to spend on materials. The price list and supplies are on display. As with most commercial building projects your customer (me) has a budget that must be kept. So your team will need to plan and used materials wisely and efficiently. You are welcome to use recycled materials that you find (nothing can be purchased) and from the “recycle” box in the classroom. Standard building supplies, hot glue, tape, staples, wood glue, tape, etc are available for your use in class. The appearance of the catapult will not be judged, but you should pay careful attention to design elements that affect the ability of your catapult to adjust to new distances. If you Google “how to build a catapult”, you can find several websites detailing what you need and how to build it. You may use one of these designs or adapt one to guide your catapult design. The assignment, rubrics and websites I found are listed on the wiki.

At the end of this unit you will use a combination of your experimental data with a class-developed model to accurately hit a designated target. On testing day you will be given the distance to the target and you will then have 10 minutes to make adjustments to your catapult. Therefore, you must design and test your catapult so that on testing day you can make whatever adjustments are needed.

You need turn in only **one report** per group. However, you will be completing a peer evaluation for every member in your group, so be sure that each team member is contributing in a meaningful way. You will have 2 full class periods to design and build the catapult (keep this in mind so that you can work at home if necessary). During the competition day, you will have 10 minutes to set up your catapult so that it can fire the projectile the required distance.

**REQUIREMENTS FOR CATAPULT DESIGN**

* The catapult must have a throwing arm of no longer than a standard ruler's length.
* The catapult must include a device on the throwing arm to hold a round projectile in place until the moment of launch.
* The catapult must be either weight or spring activated (one or the other)
* The catapult must allow for easy and measurable regulation of the force applied and the angle of launch (this means that the catapult throwing arm can be stopped suddenly at a certain point).
* The catapult must be self-contained (free-standing) and mobile.

\*\* The catapult must be rugged enough to withstand at least 30 to 40 trials

**You will be graded on the following items:**

1. Design Plan
2. Data Analysis
3. Conclusion
4. Organization and presentation of report

* Please see the rubric for additional details

**Your Design Plan Must Include:**

1. A list of materials used (should be bulleted)
2. A diagram of your catapult. The diagram should have all dimensions labeled (including units) and should be neatly drawn. Your diagram should be drawn on plain white paper and should fill most of a single page.

**Your Data Analysis Must Include:**

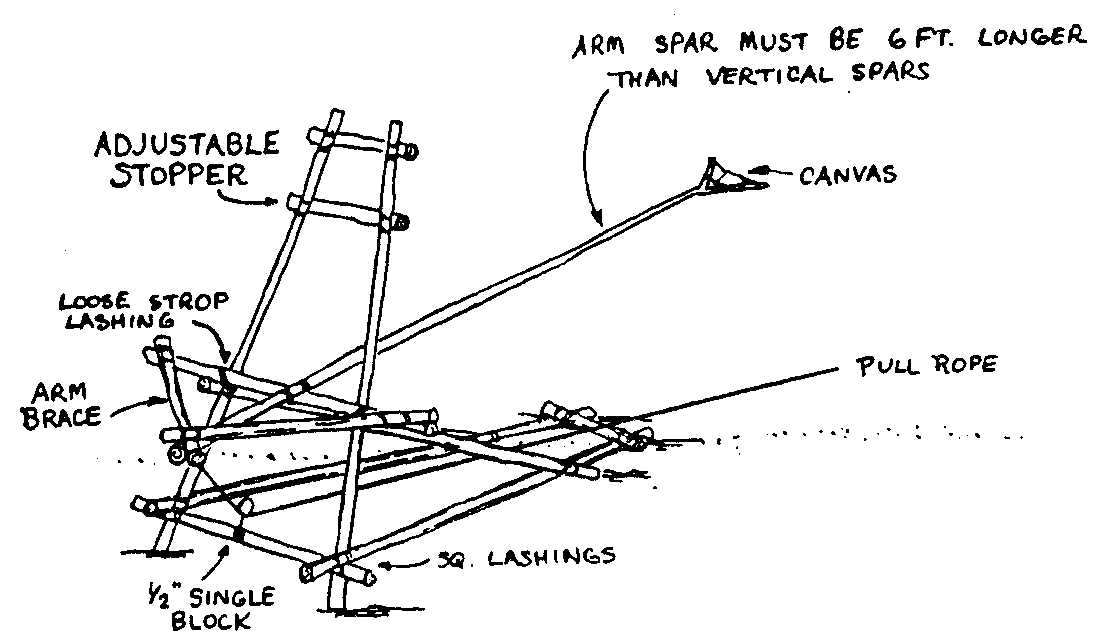
1. Data table that includes time of flight(s), distance flown in horizontal direction, and angle of launch. You must test at least 3 different angles using 3 replicate trials for each angle.
2. How did changing the angle affect the characteristics of your trajectory?

**Organization and Presentation:**

1. Report should be neatly typed or written and sections should be well marked.
2. Mistakes must be either erased or whited out.
3. All answers are presented in complete sentences excluding the list of materials which may be bulleted.

**Conclusion:**

Your conclusion should include an overview of your findings and describe any sources of error that might be present. Give some examples of real life projectiles whose landing spots must be carefully predicted.



**Rubric for Catapult Laboratory Report**

|  |  |  |  |
| --- | --- | --- | --- |
| **Outcomes** | **Below**  **Standards** | **Meets**  **Standards** | **Above**  **Standards** |
| *Statement of Objective*: States why the student is doing the investigation and what the goals are. Should be clear and concise. | 0 | 2 | 4 |
| *Design Plan:* Complete description of the catapult and diagram with all parts labeled and clearly drawn. | 0 | 2-4 | 6 |
| *Data*: All data taken should be listed in this section. All data must have units and data tables should be clearly labeled. Must include: time of flight, launch angle, and distance in x-direction. | 0 | 2-4 | 6-8 |
| *Data Analysis*: Correct equations have been used, calculations are correct and appropriate units are used. See laboratory sheet for additional requirements. | 0-2 | 4-6 | 8-10 |
| *Accuracy:* Projectile hit target on testing day. | 0 | 2 | 4 |
| *Organization and presentation:* Report is neatly typed or written, sections have been well marked, and mistakes are either erased or whited out. | 0 | 2 | 4 |
| *Participation:* Participated actively during the planning and construction phases. | 0-4 | 6-10 | 12-14 |

Total: 50 points

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| --- |
| **Student Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **CATEGORY** | **Excellent** | **Good** | **Satisfactory** | **Needs Improvement** |
| **Contributions** | Routinely provides useful ideas when participating in the group and in classroom discussion. A definite leader who contributes a lot of effort. | Usually provides useful ideas when participating in the group and in classroom discussion. A strong group member who tries hard! | Sometimes provides useful ideas when participating in the group and in classroom discussion. A satisfactory group member who does what is required. | Rarely provides useful ideas when participating in the group and in classroom discussion. May refuse to participate. |
| **Attitude** | Never is publicly critical of the project or the work of others. Always has a positive attitude about the task(s). | Rarely is publicly critical of the project or the work of others. Often has a positive attitude about the task(s). | Occasionally is publicly critical of the project or the work of other members of the group. Usually has a positive attitude about the task(s). | Often is publicly critical of the project or the work of other members of the group. Often has a positive attitude about the task(s). |
| **Working with Others** | Almost always listens to, shares with, and supports the efforts of others. Tries to keep people working well together. | Usually listens to, shares, with, and supports the efforts of others. Does not cause "waves" in the group. | Often listens to, shares with, and supports the efforts of others, but sometimes is not a good team member. | Rarely listens to, shares with, and supports the efforts of others. Often is not a good team player. |
| **Quality of Work** | Provides work of the highest quality. | Provides high quality work. | Provides work that occasionally needs to be checked/redone by other group members to ensure quality. | Provides work that usually needs to be checked/redone by others to ensure quality. |
| **Preparedness** | Brings needed materials to class and is always ready to work. | Almost always brings needed materials to class and is ready to work. | Almost always brings needed materials but sometimes needs to settle down and get to work | Often forgets needed materials or is rarely ready to get to work. |